

UNITED STATES MARINE CORPS

LESSON PLAN

TEMPERATURE MEASUREMENT

INTRODUCTION:

1. Gain Attention. "Cold as a snowstorm" and "hot as hell". These are phrases we use to describe the temperature of an object. The temperature of an object determines the sensation of warmth or coldness felt from contact with it. These are backward phrases and not meteorological terms. We use degrees to represent temperature. There are three main temperature scales we will discuss during this period of instruction, they are the Fahrenheit, Celsius, and Kelvin scales.

2. Overview. During this class the student(s) shall learn how to convert temperatures from one scale to another. You will also learn a brief history of all three of the scales.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of references, explain the different temperature measurement scales and their history.

b. Enabling Learning Objective(s). Given a specified temperature, and without the aid of references, perform the following conversions:

- (1) Fahrenheit to Celsius.
- (2) Fahrenheit to Kelvin.
- (3) Celsius to Fahrenheit.
- (4) Celsius to Kelvin.
- (5) Kelvin to Celsius.
- (6) Kelvin to Fahrenheit.

4. Method/Media. This period of instruction will be taught using the lecture method with aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".

5. Evaluation. You will be evaluated by demonstrating the ability to manually convert given temperatures from one scale to another. You will also be asked questions on the history of each temperature scale and its primary use.

TRANSITION. Temperature is a measure of the motion of the individual atoms and molecules in a gas, liquid, or solid. The scale we use for temperature is "degrees" (°). There are three temperature scales that are used today. The Kelvin (K) scale is used by scientists and for

astronomical temperatures. The Celsius scale (°C) is used by most of the world to measure air temperatures. In the United States, the Fahrenheit scale (°F) is used to measure temperatures at or near the surface.

BODY:

1. Fahrenheit Temperature Scale. Fahrenheit temperature scale is a scale based on 32° F for the freezing point of water and 212° F for the boiling point of water.

a. The 18th-century German physicist, Daniel Gabriel Fahrenheit originally took the zero of his scale as the temperature of an equal ice-salt mixture and selected the values of 30° F and 90° F for the freezing point of water and normal body temperature, respectively; these later were revised to 32° F and 96° F, but the final scale required an adjustment to 98.6° F for the human body temperature value.

(1) Until the 1970s the Fahrenheit temperature scale was in widely common use in English-speaking countries; the Celsius also known as the centigrade, scale was employed in most other countries and for scientific purposes worldwide.

(2) Since that time, however, most English speaking countries have officially adopted the Celsius scale.

b. Conversions.

(1) To convert Fahrenheit to Celsius, use the following formula:  $(98.6 - 32) / 1.8 = 37^{\circ}\text{C}$

(2) To convert Fahrenheit to Kelvin one must first convert the temperature to Celsius then add 273 to the number as follows:  $(98.6 - 32) / 1.8 = 37^{\circ}\text{C} + 273 = 310\text{K}$ . The reason behind this as you will learn, is the Celsius and Kelvin scales are both on a scale that is 100° between freezing and boiling points, therefore each degree is worth the same magnitude in these scales.

c. The United States is the only nation that continues to use Fahrenheit temperatures for surface weather observations. However, as of July 1996 all surface temperature observations in National Weather Service METAR/TAF reports are now transmitted in degrees Celsius.

2. Celsius Temperature Scale. The Celsius temperature scale is sometimes referred to as the "centigrade" scale. Centigrade is defined as "consisting of or divided into 100 degrees."

a. History. The Celsius scale, devised by Swedish Astronomer Andres Celsius (1701-1744) for scientific purposes, has 100 degrees between the freezing point of 0 degrees and boiling point of 100 degrees of pure water at sea level air pressure, 29.92 inches of mercury. That pressure criteria is often called an atmosphere, or more commonly know as a standard pressure. The term Celsius was

adopted in 1948 by an international conference on weights and measures. This is the most widely used scale in the world.

b. Conversions.

(1) Converting Celsius to Kelvin. To obtain the conversion of Celsius to Kelvin, use the following formula:  $K = ^\circ\text{C} + 273$ .

(2) Converting Celsius to Fahrenheit. To obtain Fahrenheit to Celsius, use the following formula:  $F = C \times (1.8) + 32$ .

3. Kelvin Temperature Scale. Kelvin temperature scale is the base unit of thermodynamic temperature measurement in the International System of measurement.

a. It is defined as 1/ 273.16 of the triple point (equilibrium among the solid, liquid, and gaseous phases) of pure water.

b. The Kelvin (symbol K) without the degree sign ( $^\circ$ ) is also the fundamental unit of the Kelvin scale, an absolute temperature scale named for the British physicist William Thomson Baron Kelvin.

c. Such a scale has as its zero point absolute zero, the theoretical temperature at which the molecules of a substance have the lowest energy.

d. The Kelvin scale has been adopted as the international standard for scientific temperature measurement. The Kelvin scale is related to the Celsius scale.

e. The difference between the freezing and boiling points of water is 100 degrees in each, so that the Kelvin has the same magnitude as the degree Celsius.

f. Conversions.

(1) To convert Kelvin to Celsius, use the following formula:  $K = C + 273$ .

(2) To Convert Kelvin to Fahrenheit, one must first convert Kelvin to Celsius ( $K = C + 273$ ), and then convert Celsius into Fahrenheit ( $F = C \times (1.8) + 32$ ).

Table 1 - Comparison of temperature scales.

Temperature Scales			
Fahrenheit	Celsius	Kelvin	
212	100	373	Boiling point of H <sub>2</sub> O at sea-level
194	90	363	
176	80	353	
158	70	343	
140	60	333	
122	50	323	
104	40	313	
86	30	303	
68	20	293	Average Room Temp.
50	10	283	
32	0	273	Melting/Freezing point of H <sub>2</sub> O at sea-level
14	-10	263	
-4	-20	253	
-22	-30	243	
-40	-40	233	
-58	-50	223	Lowest temperature ever recorded Vostok, Antarctica July 1983 -89°C/-129°F
-76	-60	213	
-94	-70	203	
-112	-80	193	
-130	-90	183	
-148	-100	173	

#### OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time are there any questions pertaining to the information that has just been presented to you?
2. Questions to the Class.
  - a. Question. What are the primary uses of each individual temperature scale?
  - b. Answer. The primary use for the Fahrenheit scale in the United States, the Fahrenheit scale (°F) is used to measure temperatures at or near the surface. The Celsius scale (°C) is used in most of the world to measure air temperatures and in meteorology. The Kelvin (K) scale is used by scientists and for astronomical temperatures.

SUMMARY: During this period of instruction you have learned that each different temperature scale has many different uses, also you have learned how convert each of them to the opposite temperature scale ie; Fahrenheit to Celsius, Celsius to Fahrenheit, Kelvin to Fahrenheit and Kelvin to Celsius.

#### REFERENCE:

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Glickman, Todd S. Glossary of Meteorology, 2<sup>nd</sup> Edition. American Meteorological Society, Boston Massachusetts, U.S.A.

Ahrens, Donald C. Meteorology Today. 4<sup>th</sup> Edition. West Publishing Company, 1991

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